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The amount of salt in irrigation water injurious to rice

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THE AMOUNT OF SALT IN IRRIGATION WATER INJURIOUS TO RICE.

BY

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An extreme drought during the irrigating season in the rice belt does not occur frequently. When such does happen, however, certain streams which normally supply an abundance of fresh water for large rice acreage may become brackish and thus injurious to rice. The season of 1917 was such a one. The water in many of the large streams became brackish in June. Later in the season the amount of salt per gallon ranged from 10 to 500 grains.

It is commonly believed by the rice farmers and canal men that not more than 35 grains per gallon should be used on rice. Information on the amount of salt rice will withstand is not available. The following are some of the inquiries that would arise under conditions experienced during 1917.

1. If the ground is wet but not flooded with fresh water will one six-inch flooding with water containing 35 grains of salt per gallon be injurious if same be followed by fresh water?

2. Will two floodings of 35 grains per gallon be injurious?

3. Will continuous flooding with 35 grains per gallon be injurious?

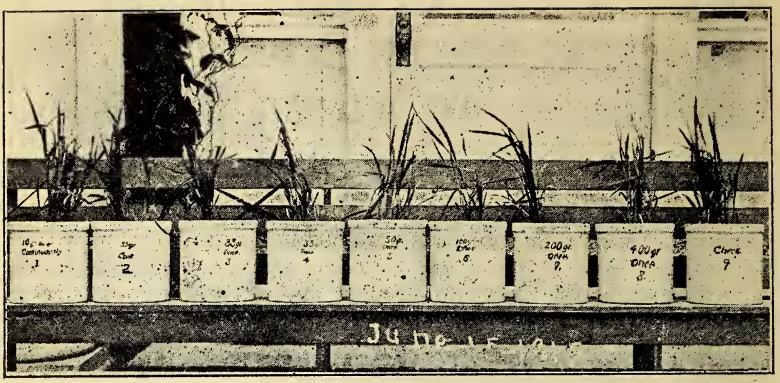
4. Will a flooding of 50 grains per gallon be injurious?

5. Will a flooding of 100 grains per gallon be injurious?

6. What effect will salt have on the grain when matured?

7. What will be the effect on the soil?

In order to secure more authentic information on this subject the following experiment was established.



The rice at the beginning of the experiment, June 15.

Growing rice from the field was placed in nine two-gallon earthernware jars. When placed in the jars the rice was about eighteen inches high. The plugs of earth containing the rice plant roots were carefully cut so that they fitted the jars exactly. The rice roots were not disturbed. The variety was Experiment Station Selection No. 2010, called Brazla, an early rice of the long grain type similar in growing period and type of grain to Honduras. The land was absolutely dry at the time of transplanting. There was room in the jars for three inches of irrigation water. The rice was placed in the jars June 12 and flooded

June 28. **Note that 100, 200 and 400 grain applications are beginning to show the effect of the salt.**

for two days with fresh water. June 15 the fresh water was drained off, leaving the soil wet, and the salt solutions to be used in the experiment were applied. The salt solutions were prepared and applied by Otto Jaschke, chemist in charge of the Kaplan Laboratory in Crowley.

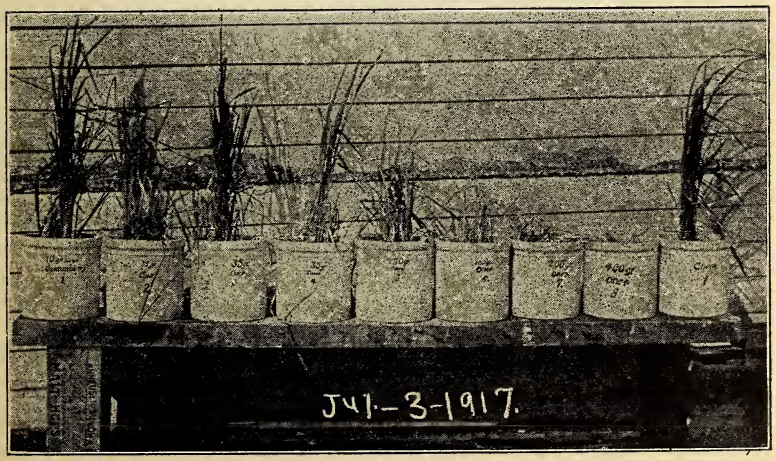
Following is an outline of the experiments with notes on same from June 15 to the end of the experiment.

Pot No. 1. All of the irrigation water used in this experiment contained ten grains of salt per gallon. There was no observable effect on the rice.

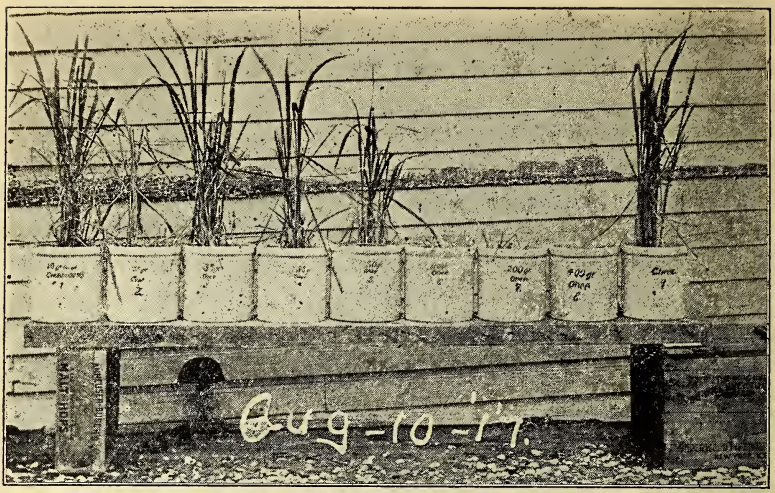
Pot No. 2. All of the water used in this experiment contained 35 grains per gallon. About 40 acre-inches were applied. By July 1 the effect of the salt could be observed. August 15 the rice was not over half the size of the check. By September 10 the rice was entirely dead. The check (No. 9) and No. 1 produced good heads.

Pot No. 3. By June 20 six inches of water had been applied containing 35 grains of salt per gallon followed by subsequent irrigations of fresh water. The effect of the salt could not be observed. The heads and grains seemed normal.

Pot No. 4. By July 3 this pot received 12 acre-inches of water or two six-inch irrigations of water containing 35



July 3. All of the rice that received above 35 grains of salt (Pot 3) is badly injured; from 100 to 400 grain applications, dead.



August 10. Note that the rice in Pots 4 and 5 is beginning to recover because of the fresh water.

grains of salt per gallon. After this fresh water was used. Early in July the effect of the salt could be observed to a limited degree. In this pot the rice was injured to a considerable extent. It is estimated that rice of this kind would produce about half a crop. In this case the salt seemed to delay the heading. The heads were badly filled and the grains light.

Pot No. 5. This experiment received one six-inch flooding of water containing 50 grains of salt per gallon followed by fresh water. By June 28 the effect of the salt could be easily observed and two weeks later the plants had the appearance of being half dead. After the fresh water was put on, the rice seemed to recover. It is believed that a crop of this kind of rice would be about 25 per cent short.

Pot No. 6. By June 20 this pot had received 6 acre-inches of water containing 100 grains of salt per gallon. By June 28 the effect of the salt was easy to observe. By July 25 the plants of this experiment were completely dead. Fresh water was applied after June 20.

Pot No. 7. By June 20 this experiment had received 6 acre-inches of water containing 200 grains of salt per gallon. The effect of the salt could be observed in ten days from the time of application and by July 12 the plants were completely dead.

Pot No. 8. By June 20 this experiment had received six acre-inches of water containing 400 grains per gallon. After this fresh water was applied. By July 1 all the plants of this experiment were completely dead.

Pot No. 9. Check pot received fresh water as required and commenced to head August 15. The rice seemed normal in every way.

September 10. Note that 35 grains continuous flooding (Pot 2) is dead. 35 grains once, 35 grains twice, and 50 grains once (Pots 3, 4, and 5 respectively) are about equal in size and quality of grain. All three are as good in size but not in quality of grain as the check pot (No. 9). Compare Pot 5 in this cut with Pot 5 in cut of July 3.

EXPERIMENT UNDER FIELD CONDITIONS

AT ESTHERWOOD, LA.,

By Jaschke and Hoffpauir.

In a field of Blue Rose rice near Estherwood, La., five plots were established. The plots were 5 by 10 feet square and surrounded by a good substantial levee. The land was flooded with fresh water when the plot levees were constructed. The plots were drained and the tested solutions of salt water applied as indicated in the table. The water was obtained from a nearby well. The solutions were mixed in barrels and applied to the land with buckets. The plots were flooded with the solutions about three inches deep through the entire growing season. Following is all of the data in connection with the plots.

	PLOT 1	PLOT 2	PLOT 3	PLOT 4
Grs. Salt per Gal. Water Used	25	35	50	75
July 28—Irrigation, Gallons Used	250 Gal.	250 Gal.	250 Gal.	250 Gal.
July 31, 2nd Irrigation	200 Gal.	200 Gal.	200 Gal.	200 Gal.
August 2, 3rd Irrigation	100 Gal.	100 Gal.	100 Gal.	100 Gal.
August 9, 4th Irrigation	100 Gal.	150 Gal.	150 Gal.	150 Gal.
August 15, 5th Irrigation	150 Gal.	200 Gal.	200 Gal.	200 Gal.
August 28, 6th Irrigation	100 Gal.	100 Gal.	100 Gal.	100 Gal.
September 11, 7th Irrigation	100 Gal.	100 Gal.	100 Gal.	100 Gal.
September 20, 8th Irrigation	200 Gal.	200 Gal.	200 Gal.	200 Gal.
September 29, 9th Irrigation	200 Gal.	200 Gal.	200 Gal.	200 Gal.
Salt Applied per Acre.	4224 lbs.	6600 lbs.	9427 lbs.	14080 lbs.
Yield of Rice per Acre.	3049 lbs. (18.8 bbl.)	2450 lbs. (15.1 bbl.)	1524 lbs. (9.4 bbl.)	1143 lbs. 7.05 bbl.)
Quality of Grain.	Good	Fair	Bad	Bad
Pounds per Bushel—Cup Test.	42	40	41	37

Ripe rice in plot 1 of the Estherwood field experiment. Irrigated with water containing 25 grains of salt per gallon.

The data on plot 5 is considered of no value and is not given in this table. It was found that clay from the well had been at one time thrown on this plot which prevented seepage in the same degree as the others; as a result less water was required to keep this plot flooded. Again because of the clay the salt solution did not gain access to the roots as readily as on the other plots. The solution used on plot 5 contained 100 grains of salt per gallon; yet at the end of the test not as much salt had been used as on the other plots. This may perhaps indicate that on very heavy clay land more salt can be used without injury than on the lighter soils.

In comparing the pot experiment with the field experiment at Estherwood attention is invited to the fact that in the pots there could be no seepage and no loss of water other than the evaporation. No rain was permitted to fall on the pots. In the field experiment there was a certain amount of levee seepage and soil percolation. During July and August several small rains fell on the plots. The rains were unusually light for the season probably amounting to

one or two acre-inches. (Station record of precipitation could not be used in this case because it is known that several more inches of rain fell at the station during this period than at Estherwood.) It is believed that the pot experiment is a good indication as to the amount of salt that rice will withstand, but that it does not represent field conditions with reference to seepage, percolation, and rainfall.

In all observations made by the writer the quality of the grain was found to be affected in rice produced in salt solutions where the amount of salt per gallon was 35 grains or more. The sample of rice raised in plots 3 and 4 of the Estherwood experiment was decidedly bad. The grains were in many cases light and twisted. The rice was soft and chalky. In a sample of this kind the percent of head rice in the mill must necessarily be very low.

A great many contradictory reports were received during the season with reference to salt-water damage. There were many reports of good crops raised with as much as 100 grains per gallon of salt. Unfortunately, all of these

Ripe rice in plot 4 of the Estherwood field experiment. Irrigated with water containing 75 grains per gallon. See table of yields. The quality of the grain is very poor.

Typical Plants from Plots 1, 3, and 4 from right to left.
Estherwood Field Experiment.

reports could not be investigated. Of those on which the true data was secured the following is a fair sample.

A farmer, living near Abbeville, La., stated that he raised a good crop of rice with water that ranged from 100 to 150 grains of salt per gallon. It was found that 40 acres of Japan and Honduras rice having a certain amount of fresh water on same at initial irrigation with salt was irrigated as stated, but that the salt water was run over the fields and drained out on the lower side. The average yield per acre in this case was found to be about four bags. The quality of the rice from the lower part of the field was very poor.

On the other hand we have the statement of Mr. J. E. Broussard, president of the Beaumont Rice Mills and one of the largest growers of rice in Texas, that good rice can be produced with water containing 50 or more grains of salt per gallon. Mr. Broussard's letter is published herewith.

"Beaumont, Texas, Nov. 2, 1917.

"Mr. F. C. Quereau, Asst. Director in Charge,
Rice Experiment Station,
Crowley, La.

"Dear Sir:

I have yours of the 30th and note that you will soon publish a tabulation of experiments on salt water for rice irrigation, and I have the following:

First—One field of about 400 acres belonging to me, being practically all black hog wallow land, was planted in rice and the first irrigation was made about the middle of June with water containing 35 grains per gallon at the start, and we finished irrigating at that time when the water contained 55 grains per gallon. From that on the land was irrigated three or four times and at no time did the water contain less than 35 grains, and the last part of each irrigation period the water contained as much as 55 grains. After this the land was irrigated three or four times. We commenced pumping when the water contained 35 grains and stopped pumping when it reached 55 grains. This rice made a very good yield; some of it making as much as 15 bags per acre, while other portions of it where the water was very shallow and the same was only irrigated a couple of times made about 5 sacks. The entire field will average between 10 and 11 sacks and the rice is of excellent quality, all Blue Rose.

"Second—This was irrigated about the first of June with fresh water, but the water became salty about July 1 and no water was used until about the middle of July or later when we began irrigating with water containing 100

grains per gallon. Most of the fields were irrigated with this water though a large portion of it was watered at this time with water containing 150 grains. The next water was along about the middle to the last of August when water containing 150 grains per gallon was used. The rice is now being threshed and some fields are making as much as 10 to 11 bags per acre while others will not make more than five or six. It seems that where the water was used on the side hills and was dry a large portion of the time that the rice will make very poorly, but where the water stood in the fields most of the time the rice is giving very good yields. A portion of this crop is Honduras and a portion Blue Rose. The Blue Rose seems to stand the salt water better than the Honduras.

"Very truly yours,
The Beaumont Rice Mills,
J. E. Broussard."

It may be of interest to the rice farmer to know the amount of salt applied to the land through the use of salt water of different concentrations. Rice requires on an average of from 45 to 60 acre-inches of water. During a season similar to that of 1917, giving consideration to the leakage of the levees, drainage at harvest, and one or two irrigations of fresh water prior to the application of salt water, the amount of brackish water which under ordinary conditions is added to fresh water already in the field from previous irrigations will seldom exceed 30 acre-inches out of a possible total of 60 acre-inches for the entire crop.

(1) 27,154 gallons are required to flood 1 acre 1 inch deep. If the water contains 35 grains per gallon of salt (7,000 grains per pound), then the above acre-inch will if it evaporates on the field apply to the soil 135.6 pounds of salt. Thirty acre-inches will apply 4,068 pounds of salt.

(2) If the water contains 25 grains of salt per gallon, 1 acre-inch will apply 96.9 pounds of salt, and 30 acre-inches will apply 2,907 pounds.

(3) If the water contains 50 grains per gallon, 1 acre-inch will apply 193.9 pounds of salt, and 30 acre inches will apply 5,817 pounds.

(4) If the water contains 100 grains per gallon, 1 acre-inch will apply 387.9 pounds of salt and 30 acre-inches will apply 11,637 pounds per acre.

1 acre-inch of water is equal to 6,272,640 cubic inches. A gallon contains 231 cubic inches. 7,000 grains troy is equal to 1 pound avoirdupois.

The above may be of value to the farmer in making calculations which will be of service to him when using irrigation water containing salt.

From the data at hand it would seem safe to make the following suggestions with reference to the use of brackish water on rice.

(1) Do not use more than 35 grains per gallon of salt in a flooding of from 4 to 8 inches if this amount of salt water is to remain on the field until it evaporates or is diluted with fresh water.

(2) Do not flood a second time with water containing more than 15 grains of salt per gallon.

(3) It may or may not be harmful to use water containing 50 grains of salt on land which is wet prior to the application of the salt water, when it is possible to remove all of the salt water and replace with fresh water within two weeks of the time that the salt is applied.